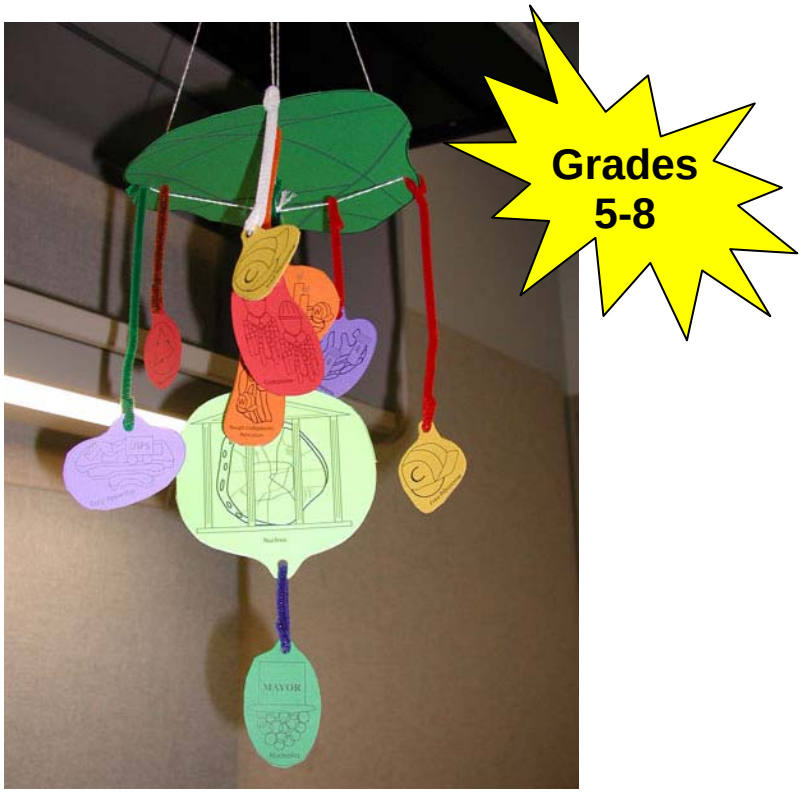
City Within a Cell

Mobile Activity



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http://slsd.jsc.nasa.gov/bso/

“City Within a Cell” Mobile Activity

Introduction

This activity implements kinesthetic learning to inspire students to create and work with their hands while developing a stronger understanding of the cell and its parts, or “organelles” as they relate to an analogy of a city. Students will give examples of items within a city and then be given descriptions of cell parts. Students will match the current cell part and its description to prior knowledge of a city component. Then, students will build their own Cell City mobile.

The purpose of this activity is to build a cell model with an alteration to cell design which will allow more visualization of the cell’s inner parts. While cells are enclosed structures, this model will dangle as a mobile and demonstrate the level of intracellular organization in a more linear format.

The cell body and cell (plasma) membrane functions as the main support structure for the mobile. All other parts are directly or indirectly carried by the cell body. The nucleus is a secondary platform to support other organelles. Further explanation of the mobile construction will follow later in this education brief.

Supplies

Tag board and/or construction paper
Templates of analogous cell parts
Varied lengths of pipe cleaners
Scissors
Paper hole punch
Thread or nylon fishing line
4-hole button

Optional or alternative materials

Color crayons or pencils
Glue
Craft pom-poms
Glitter
Plastic egg
Green or blue saran wrap
Cellophane tape
Aluminum foil
Staples and stapler

Preparation

1. Choose as many of the cell parts that you wish to discuss and use in your mobiles before the lesson begins. Suggested components are shaded gray in the table. The cell body is mandatory as it provides the structure to suspend the other cell components.
2. Print out templates of the necessary cell parts on different colors of tag board. Alternative method: print templates on plain white paper and have students cut them out and trace them on tag board or construction paper.
3. Cut two pieces of thread about 4’ long to hang the mobiles.
4. Gather other supplies for students to complete their cell mobiles.

Lesson

1. Ask for students to raise their hands to be called upon and name large parts of a city. What makes up a city?
2. Write all the suggestions down on a large board for them to see as each student offers a suggestion.
3. Make sure that you accumulate the names of parts you chose beforehand. Consider using pictures of city items as prompts.
4. Give clues and descriptions (see table below) about each part of the cell that you chose and have the students guess the part of the city that matches the same purpose or activity. As an example, use the relationship of a city to a cell.

- For example, say: “The cell body provides the location for cell parts to live and for many activities of working parts, deliveries of products, and factories that make products.”

5. Hand out cut-outs of the analogous cell parts for students to cut out and/or color.
6. Punch holes in the templates using the circle guides.
7. Push one end of the thread down through a hole in the tag board circle (cell body), over to the hole on the opposite side of the cell body and then up through the hole, holding the ends of the thread together at the top. Repeat this with the other piece of thread and the remaining two holes on the cell body. Tie the four ends of thread to a button which will serve as a holder to hang your mobile from the ceiling.
8. Attach each of the cell parts to the cell body with varying lengths of pipe cleaners.
    a. Optional items that are not attached with pipe cleaners are:
        i. Bound ribosomes (glued to Rough ER/Factory)
        ii. Cell membrane and Nuclear envelope (aluminum foil with staples or glue)
        iii. Chromosomes (accordion-folded paper strips fed through slits in nucleus)
        iv. Cytoplasm (taped or stapled strips of green or blue saran wrap)
9. Hang up your mobile for all to enjoy!!!

Cell Part	City Analogy	Clues and descriptions
EXAMPLE: Cell body	“City”	Provides the location for cell parts to live and for many activities of working parts, deliveries of products, and factories that make products.
Cell Membrane	“City limits/wall”	Provides the boundaries for the activities that go on within the cell
Centrosomes	“City planners / architects”	Plan out how the city divides Control how things are moved within the cell
Chromosomes	“City plans”	The plans for how the cells are built and how products are made
Cytoplasm	“Community”	The part of the cell outside of the nucleus
Cytoskeleton	“Roads”	Provides paths for parts of the cell to move
Golgi Apparatus	“Postal service”	Packages up things made in the cell and ships them out
Lysosome	“Wrecking ball”	Breaks down old or damaged parts of the cell
Mitochondrion	“Power plant”	Creates and stores energy/power for the cell
Nuclear Envelope	“City hall walls”	Surrounds the nucleus
Nucleolus	“Mayor”	Figure for the cell and most noticeable part of the nucleus
Nucleus	“City Hall”	Control center for the cell Gives directions for construction within the cell Holds the blue prints for building
Peroxisome	“Recycling machines”	Move about the cell and absorb old parts of the cell to reuse them
Ribosome	“Workers”	Makes all kinds of things to use in the cell and to send out of the cell. Works inside of larger buildings or free within the city
Rough Endoplasmic Reticulum	“Factory”	Workers here make all kinds of things for use in the city and out of the city
Smooth Endoplasmic Reticulum	“Pharmaceutical Plant”	Hormones and steroids, medications, are made here.

Example

The Cell

This section will provide a background on the cell and its parts. You can find a related interactive game online at http://slsd.jsc.nasa.gov/bso.

CELL

The most basic unit of life, cells are microscopic cities. They are filled with a watery fluid called protoplasm and numerous small machines called organelles or “little organs.” Cells’ small size allow for more surface area in relation to their volume. They may be part of larger tissues and organisms or be single-celled beings on their own like bacteria. Cells are divided into two groups: prokaryotes and eukaryotes. Prokaryotes are the most simple, single-celled organisms and do not have a nucleus bound in a membrane. Most cells however, are eukaryotic such as this human cell.

CENTROSOME

The centrosome is an important part of the cell’s cytoskeleton. It is located near the nucleus and is the
organization center for part of the cell’s skeleton (microtubules). The centrosome contains a pair of centrioles which is a collection of 27 microtubules. When a cell prepares to divide, the two centrioles copy themselves to make four. Each pair of centrioles moves to opposite ends of the cell. These centrioles then act like two team captains, sending out microtubules to choose “players” (chromosomes) for their “teams” (two new cells).

CELL MEMBRANE

All human and animal cells have a kind of skin called a “membrane.” The cell membrane is also known as the plasma membrane and allows nutrients, wastes, and cell products to pass through it. It controls the movement of anything into and out of the cell like a city wall with gates. Only so much of each thing can cross through “the gate” per second so membrane surface area is very important. Membranes between some parts of the cell are interchangeable. The Golgi Apparatus sends its secretion vesicles in its membrane to the outer cell membrane where the membranes combine

together as part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

CHROMOSOME
Chromosomes are made of DNA (deoxyribonucleic acid) and proteins and are found in the nucleus. Usually, they are difficult to see as individual chromosomes, looking very stringy and tangled. This mess of genetic material is called chromatin. Chromosomes carry genes in linear order and when the cell is about to divide, they get organized and are the most visible thing in the nucleus. Different animals have different numbers of
chromosomes. For example, human cells generally have 46 chromosomes.

CYTOPLASM
The cytoplasm is the part of the cell outside of the nucleus but together, they make up the protoplasm. The
cytoplasm has a neutral pH of 7 and a watery fluid called cytosol where many of the organelles (“little organs”) are found. Free-floating ribosomes can be found here, too. The cytoplasm also contains remains of cell parts (“floaties”) broken down by the cell “clean-up crews” (lysosomes). These remains are the building blocks (precursors) used by organelles to rebuild themselves such as the Endoplasmic Reticulum’s membrane.

CYTOSKELETON
The cytoskeleton not only provides the “bones” for the cell but also the “muscles.” It is a mesh of fibers that
maintains the shape of the cell, provides a place for organelles to anchor to, causes movement of the cell, and adds a “monorail system” for the organelles and vesicles to travel along. Some cells have moving hairs, tails, or bumps (cilia, flagella, microvilli) whose movement is also caused by the cytoskeleton. There are three main types of fibers in the cytoskeleton known as the microtubules (thickest), intermediate filaments, and microfilaments (thinnest; a.k.a. actin filaments).

GOLGI APPARATUS
The Golgi Apparatus is the “packing and shipping office” in the cell. Some say that it looks like a stack of pita bread. It is actually an organelle with many sac-like compartments called cisternae. The Golgi has a “receiving” side and a “shipping” side. It receives proteins from the Rough ER (Rough Endoplasmic Reticulum) and alters them for different uses. Some proteins from the Rough ER are packaged and sent (secreted as secretory vesicles) out of the cell. The Golgi also wraps proteins with membrane and coats them with markers to help them “dock” with other organelles. The Golgi gets membrane from the Rough ER and is part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

LYSOSOME
Lysosomes are the “clean-up crews” of the cell. They are sacs (vesicles) of acidic (pH 5) proteins made by the Rough ER (Rough Endoplasmic Reticulum) that can dissolve bacteria, old cells, organelles, and materials that do not belong in the cell. A cell may surround something unwanted and contain it, or “eat” (phagocytosis) it in a stomach-like vacuole. Lysosomes break into the vacuole and release their dissolving proteins. By breaking up organelles within the cell, they create a supply of “spare parts” or “floaties” that remain in the cytoplasm until they become building blocks (precursors), reused by other organelles. When an entire cell needs to be destroyed, lysosomes within the cell can all break open and destroy the entire cell (autolysis; giving lysosomes the nickname “suicide sacs.”)

MITOCHONDRION
A mitochondrion is the “powerhouse” of the cell. There can be many mitochondria in a cell’s cytoplasm. In fact, the number of them found gives an idea of the amount of energy needed for the cell. Mitochondria use free ribosomes in the cytosol and have their own ribosomes to make their own double membrane. They pull “spare parts” from the cytosol to make the smooth outer membrane and the many folds (cristae) of the inner membrane. The folds offer more surface area to change oxygen and glucose, a form of sugar, into energy in the form of ATP (adenosine triphosphate). Mitochondria are the size of a single bacteria and have their own DNA.

NUCLEAR ENVELOPE
The nuclear envelope is the double membrane around the nucleus in eukaryotic cells. It is the main difference between prokaryotes and eukaryotes because prokaryotes do not have one. This membrane has pores that allow passage of substances in and out, such as mRNA (messenger ribonucleic acid), from the nucleus to go out to the cytoplasm. The nuclear envelope blends into the ER (Endoplasmic Reticulum) membrane of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

NUCLEOLUS
The nucleolus is found in the *nucleus*. It is the most prominent part of the nucleus when the cell is not dividing and looks like a dark spot. A nucleolus is made of specialized regions of *chromosomes*, RNA (ribonucleic acid), and proteins. The proteins are actually ribosomes in different stages of production. More than one *nucleoli* can be found in a nucleus. They are roughly spherical in shape and are involved in the assembly of ribosomes.

NUCLEUS
The nucleus is the “control center” of the cell. It holds the cell’s inherited genes as DNA (deoxyribonucleic acid) in the form of chromosomes and controls the protein production in the cytoplasm by sending out mRNA (messenger ribonucleic acid). The mRNA is the blueprint of DNA in the nucleus and tells the ribosomes what to build.

PEROXISOME
Peroxisomes are single membrane organelles with proteins but do not come from the “packaging and shipping office” (Golgi Apparatus). Peroxisomes absorb building blocks, such as proteins and fats, from their surroundings in the cytosol and split when they get too big. They are usually spherical in shape and form hydrogen peroxide (H_2O_2) as a product of breaking down fats and toxins. Peroxisomes also convert harmful H_2O_2 to water (H_2O) with special proteins.

RIBOSOME
Ribosomes create the building blocks, or polypeptides, for forming proteins and are made by the nucleolus in the nucleus out of cytoplasm proteins and rRNA (ribosomal ribonucleic acid). They can be found “bound” to the Rough ER (Rough Endoplasmic Reticulum) or floating “free” in the cytoplasm. Ribosomes are what add the “roughness” to the Rough ER. They receive commands from the nucleus in the form of mRNA (messenger ribonucleic acid) to create polypeptides. Free ribosomes make polypeptides that remain in the cytoplasm of the cell while bound ribosomes make polypeptides that will either be part of a membrane or sent out (secreted out) of the cell. Cells that secrete hormones and enzymes have a higher amount of bound ribosomes compared to free ribosomes.

ROUGH ENDOPLASMIC RETICULUM

The Rough Endoplasmic Reticulum (Rough ER) holds many ribosomes which give it a rough appearance. It is a continuation of the nuclear envelope and merges with the Smooth ER but also makes its own membrane from “spare parts” in the cytosol. Proteins are made from ribosomal polypeptides and, in the Rough ER, will either be part of membranes or eventually sent (secreted as secretory vesicles) out of the cell by the Golgi Apparatus. Cells that send proteins out are common in the stomach and intestinal lining to digest food. They are also found in the pancreas to form insulin, a protein to help break down a complex stored form of sugar (glycogen). The Rough ER adds sugar chains to the proteins and gives up part of its own membrane to wrap them for shipping to the Golgi Apparatus (packaging and shipping center). The Golgi also absorbs the Rough ER wrapping membrane to include in its own membrane as part of the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane).

SMOOTH ENDOPLASMIC RETICULUM

Together, the Smooth and Rough Endoplasmic Reticulum (ER) make up a large network of membranes within the cytoplasm called the endomembrane system (Nuclear Envelope, Endoplasmic Reticulum, Golgi Apparatus, and Cell Membrane). The Smooth ER makes its own membrane from “spare parts” in the cytoplasm. It also makes fats, hormones, and steroids such as testosterone, estrogen, and adrenaline. The Smooth ER helps with the break down of complex sugars stored in the liver and also makes proteins (enzymes) that detoxify drugs and poisons. It makes poisons more soluble and easier to flush out of the body. Tolerance to medication is due to increased amount of the Smooth ER and its enzymes.